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Title

Personal and social norms for food portion sizes in lean and obese adults

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Abstract

Background: Portion size is an important component of dietary advice for weight control, but little is known about what portion sizes people consider "normal". This study determined the effect of BMI, gender, dietary restraint, and liking of the food on personal and social portion size norms for a range of foods, and the degree of certainty over the norms.

Methods: 30 lean (BMI 20-25kg/m^2) and 30 obese (BMI 30-35kg/m^2) men and women (aged 18-60years) viewed 17 different portion sizes of 12 foods on a computer screen on two occasions a week apart. Participants responded 'more' or 'less' to each photograph reflecting personal portion size preference or perceived portion sizes of others. Personal and social norms for portion sizes of each food were determined using the method of constant stimuli giving a sigmoidal curve of the probability of answering 'less' over a range of portion sizes. The slope of the sigmoid at the norm gave a measure of certainty about the norm. Regression models were used to examine the effect of BMI, gender, dietary restraint and liking of the food on personal norms, social norms, the relationship between norms, and the slopes.

Results: Personal norms were significantly larger in the obese ($p=0.026$), men ($p<0.001$), those with lower dietary restraint ($p<0.001$), and those with higher liking for the food ($p<0.001$). Social norms were larger for women ($p=0.012$). The slopes at the norms were 30% shallower in the obese and in men ($p<0.001$).

Conclusion: Larger personal norms for portion size among the obese, men, those with lower dietary restraint, and those with higher liking for a food imply greater consumption, which may undermine weight control. Shallower slopes for norms in the obese and in men may imply less clearly defined habitual portion sizes.

Key words: Portion size, norms, obesity

Introduction

Portion control is a key behaviour in weight management interventions but there is uncertainty over recommended portion sizes [1] and little information on portion sizes habitually consumed or considered 'normal. A norm is a belief about what constitutes usual behaviour in a given situation [2] and is thought to influence how people habitually behave. It has been previously suggested that beliefs and opinions on how much is considered appropriate to eat may influence food intake [3-6]. For example, provision of information on how much of a food others eat can alter intended prospective consumption [7] and actual consumption [5, 8] of that food.

Norms for portion sizes can be split into two types: personal norms (the amount of a food a person considers to be a normal amount for themselves to eat in a given situation) and social norms (the amount of food a person believes other people consider as normal in a given situation). Some studies have assessed self-selected, ideal or typical portion sizes of various foods [9-14], but there is little information on social norms for portion size or the relationship between personal and social norms. These constructs may be better understood if it were known how clearly defined these norms may be, but to date, there are no known studies that have attempted to measure the specificity of these norms. Indeed, how certain people are about their own portion size norms has been suggested to play a key role in determining the role of external stimuli, such as the eating behaviour of others, and therefore how much is consumed [15]. Thus, less personal certainty surrounding a norm may suggest that external cues are more likely to influence behaviour.

Previous studies of portion size norms have used samples of predominantly lean participants (mean BMI of between 21.6 and 25.7kg/m^2) [9-14]. We hypothesized that among people who are overweight and obese, personal norms for portion size would be larger than those for lean

individuals due to their increased energy demands. However this hypothesis remains to be tested since it is also conceivable that the elevated energy needs are met through other aspects of the diet, such as eating frequency or the types of food consumed. Previous studies of portion size norms have found mixed evidence on the relationship between BMI and portion size, where one study has found a positive relationship [9] and two have not [10, 13]. In addition, other participant characteristics may influence norms for portion size. To date there is little and mixed evidence for an effect of gender, liking of a food and dietary restraint on portion sizes measured in previous studies [9, 12-14, 16] and it is important to examine these in a wider range of the BMIs.

This study used a computer-based task to estimate personal and social norms for portion sizes for a range of food and drink items in lean and obese adults. We investigated the effect of BMI group, gender, level of dietary restraint, and level of food liking on personal and social norms, the relationship between these norms, and how certain people are about them.

Methods

Participants

Sixty healthy men and women, between 18 and 60 years old, with a BMI of either ≥20 to <25kg/m^2 (lean group), or of ≥30 to <35kg/m^2 (obese group), were recruited for participation in the study from the local communities by Medical Research Council Human Nutrition Research and the University of Birmingham using posters, leaflets and newspaper and magazine adverts. Fifteen men and 15 women were recruited to each of the two BMI groups.

Participants were excluded for any conditions or situations that could potentially affect appetite or food intake. The exclusion criteria were: usually avoiding any of the study foods, self-reported history of eating disorders and/or active psychological illness, not being weight

stable (assessed by self-reported weight change of >4.5 kilos in the last 3 months), any medical condition or medication affecting food intake, weight or appetite (e.g. insulin, weight loss medications, oral hypoglycaemic drugs, oral corticosteroids, thyroxin), pregnancy or breastfeeding, smoking, athletic training, excessive habitual alcohol intake (>14 units per week for women and >21 units per week for men), self-reported addictions, or difficulty viewing a computer screen.

Experimental tasks

Two separate but similar computer tasks were used on two separate occasions to assess personal and social norms for a range of foods using the method of constant stimuli, similar to that used by Brunstrom *et al.* 2008 [13]. For each task pictures of 12 foods in 17 different portion sizes (a total of 254 images) were presented to the participant on a computer screen, each presentation representing a 'trial'. Twelve random orders of the images were generated to produce 12 trial blocks. Each block was presented to each participant once; therefore there were 2448 trials in each task. All participants completed both tasks, which were programmed using PsyScope X Build 57 software (http://psy.ck.sissa.it/) run on a Macintosh laptop computer.

When each food portion size picture was presented on the computer screen, the participant was asked to answer 'At a typical eating occasion when you would eat this food, would YOU normally have…?' to estimate personal norms, or, at a separate visit, 'At a typical eating occasion when this food would be eaten, most OTHER people would normally have…?' for social norms. Two possible responses were offered: 'more' or 'less'. The participant answered by pressing the 'h' key for 'more' and the 'space bar' key for 'less'. The key stroke responses given to each picture were collected automatically by the computer in a text

119 file as the experiment progressed. For each participant, each food and each portion size, the
120 number of times the participant answered 'less' was determined.

121 The following function representing a symmetrical sigmoid curve, which allows data of this
122 sort to be smoothed out to account for any fluctuations, was then used to model a curve of the
123 probability of the participant answering 'less' (p(less)) against the food portion size (x) in
124 Microsoft Excel® 2010:

$$p(less) = \frac{1}{1 + \left(\frac{x}{\alpha}\right)^{-\beta}}$$

125

126 α and β were adjusted to minimize the sum of the residuals between the observed and
127 modelled points. An estimate of the value of x (the portion size) at the 'point of perceived
128 equivalence' (PPE) (the point at which p(less) equals 0.5), a measure of the participant's
129 personal norm for that food, was derived for each person, each food and each question
130 (personal norm question and social norm question). The slope of the modelled curve at the
131 PPE was also recorded. The slope relates to the sensitivity to the stimulus, and thus can
132 represent the degree of certainty the participant has about the norm: a steeper slope indicates
133 greater certainty, and a shallower slope indicates less certainty. **Figure 1** gives an illustration
134 of a response curve (raw and modelled data) and how the results are derived and interpreted.

135 *Food stimuli*

136 The chosen foods represented a range of different foods widely consumed in the UK; 3 snack
137 foods (digestive biscuits, chocolate cake, and Smarties®), 3 mixed food-group meal items
138 (muesli, sandwiches and lasagne), 1 carbohydrate-based food (pasta), 1 meat-based food
139 (sausages), 1 dairy-based food (cheese), 1 fruit (banana), 1 vegetable (peas) and 1 drink
140 (orange juice).

For the majority of foods, the portion sizes were based on standard UK portions [17]. The smallest portion was one quarter of the standard and the largest was four times the standard, with the other portion sizes based on evenly spaced common logarithmic intervals (each increment increasing by 19%) between the two extremes. Portion sizes were calculated to the nearest gram.

For foods usually measured as a number rather than a weight (biscuits, sausages and ham sandwiches triangles), average portion sizes were not available, therefore standard portion sizes were assumed to be two digestive biscuits (30g), two sausages (80g), and a sandwich made with two slices of bread, served as 4 triangles (180g). Portion sizes corresponding to evenly spaced common logarithmic intervals were calculated based on the weights of the minimum and maximum portion sizes, with increments set to be reasonably close to the logarithmic intervals desired but to be more practical in terms of preparation of the foods for 'unit' foods e.g. increments of a quarter or half of a sausage or biscuit.

The food portions were photographed at 42^{o} above the horizontal (this angle was used for the food photography in the photographic atlas of food portion sizes [18]), under constant lighting, on a standard white dinner plate, bowl or glass, with a knife, fork and spoon given to act as size cues. Food portions were weighed using Salter™ electronic food weighing scales (Model 1036 SVSSDR) to the nearest gram. The pictures presented on the screen were 253 mm wide by 171 mm high.

Questionnaires

Perceived appetite (hunger, fullness, prospective consumption, and desire to eat) was measured using Visual Analogue Scales (VAS) questionnaires at the start of each test session. The participants rated how they felt at that moment in relation to each sensation (i.e. 'How hungry are you?', 'How full are you?', 'How much do you think you could eat right now?',

and 'How strong is your desire to eat?') by placing a vertical mark through a horizontal line measuring 100 mm with left and right anchors indicating the extremes of each sensation. Completed questionnaires were then measured from the left end of each horizontal line to the place where the vertical mark was drawn for each question and the measurement was recorded to the nearest millimetre.

At the end of their participation in the study, three final questionnaires were administered; a food liking questionnaire using VAS (participants rated how much they liked each of the foods used in the experimental tasks between the anchors 'Not at all' and 'Extremely'); dietary restraint was assessed using the cognitive restraint scale of the Three Factor Eating Questionnaire [19]; a questionnaire to assess which eating occasion (breakfast, lunch, dinner, dessert or snack) the participant was predominantly thinking of for each food when performing the experimental task.

Procedure

The personal norms task and the social norms task were completed in random order on separate test sessions (each lasting approximately 2.5 hours), within one month and at the same time of day for each individual participant.

At the start of the study height was measured using a wall-mounted stadiometer and weight was measured with calibrated digital scales. BMI was calculated as kg/m^2. At the start of each test session, participants were asked to complete a perceived appetite questionnaire. They were asked to answer the task question in response to six practice pictures. The practice pictures were different foods to those used in the study and the data from these practices were not analysed. The investigator was not present in the room during the task itself. In the middle of each of the 12 blocks the participant was able to take the opportunity to have a rest (approximately every 10 minutes). In the middle of each testing session,

participants had a compulsory break for 15 minutes and were offered a cup of water, tea or coffee and a biscuit. Participants were given the same drink and snack on their return visit. At the end of their second study visit, participants completed the end of study questionnaires.

Ethical approval for the study was obtained from Cambridge University Psychology Research Ethics Committee in November 2011 (Ref: 2011.72). Informed consent was obtained from all participants. The study was carried out at Medical Research Council Human Nutrition Research (MRC HNR) and the University of Birmingham School of Psychology between January 2012 and June 2013.

Statistical analysis

After the data were modelled, if a participant's responses did not cross the y = 0.5 point, the PPE was considered to be out of the bounds of the pictures presented in the study and the data point was excluded from analyses as no accurate norm could be derived (this was the case for only 64, or 4%, out of the total 1440 response curves (2 norms for each of 12 foods for each of 60 participants)).

A portion size index for both personal and social norms was created from the gram weight data. This was calculated by dividing each norm in grams by the standard food-specific portion size as specified above. Portion size index data were $\log_e$ transformed for analysis and data are presented as geometric means with 95% confidence intervals. Subject characteristics are presented as the median and interquartile range (IQR).

Multiple linear regression models were used to determine whether personal and social norms were the same, and the effects of BMI group, gender, level of liking and level of dietary restraint on norms and the relationship between personal norms and social norms. All predictor variables were included in each model. Separate models were used to examine

personal norms, social norms, and the relationship between the two. Covariates were included to control for food, eating occasion, pre-visit hunger and age. Low and high levels of liking and dietary restraint were determined by categorizing a person according to a median split (low: less than the median for the characteristic; high: greater than or equal to the median for the characteristic). Multiple linear regression models were used to determine the effect of the type of norm, BMI group, gender, level of liking and level of dietary restraint on the modelled slope at the PPE. Covariates were included to control for the gram weight estimate for the norm derived from the modelling, eating occasion, pre-visit hunger and age.

Mann-Whitney U tests were used to determine differences in subject characteristics between BMI groups. Wilcoxon signed-rank tests were used to determine whether perceived appetite ratings differed between visits. All analyses were completed using STATA® 12.0 statistics and data analysis software (StataCorp, Texas, USA).

Results

Table 1 shows the subject characteristics for the study participants. The obese group had greater dietary restraint, disinhibition, and trait hunger (TFEQ) compared to the lean group. **Table 2** gives the average raw weights for personal and social norms for portion sizes of each food.

Obese individuals were found to have significantly larger personal norms for portion sizes compared to the lean (β=0.076, p=0.026), but there was no difference between social norms (p=0.414) (**Figure 2A**). Obese individuals were also found to have significantly larger personal norms than social norms (β=-0.120, p<0.001), a difference not seen in lean individuals (p=0.150).

Men had significantly larger personal norms (β=0.177, p<0.001), and significantly smaller social norms compared to women (β=-0.082, p=0.012). Men also had significantly larger personal norms compared to social norms (β=-0.226, p<0.001), but for women there was no significant difference between norms (p=0.073) (**Figure 2B**).

For those with higher dietary restraint, personal norms were significantly smaller compared to those with lower restraint (β=-0.165, p<0.001), but the difference between social norms did not reach significance (p=0.055). Those with lower restraint had significantly larger personal norms than social norms (β=-0.169, p<0.001), but there was no significant difference between norms for those with higher restraint (p=0.601) (**Figure 2C**).

Those with higher liking had significantly larger personal norms (β=0.142, p<0.001) but there was no difference in social norms (p=0.530). Those with higher liking had larger personal norms compared to social norms (β=-0.142, p<0.001), but here was no significant difference between norms for those with lower liking (p=0.581) (**Figure 2D**).

Slopes at the norm were shallower for social norms than for personal norms (β=-0.186, p=0.002), for men compared to women (β=-0.261, p<0.001) and for the obese group compared to the lean group (β=-0.358, p<0.001) (**Figure 3**). There were no effects of restraint or liking (p>0.107) (**Figure 4**).

It is evident from these data that, on average, the portion size index was considerably greater than one, indicating that the portion size norms estimated in this study were greater than the UK reference portion sizes.

Discussion

Personal norms for portion sizes were larger among the obese, men, those with lower dietary restraint, and those with higher liking. This suggests these groups may habitually choose

larger portions which, in the absence of any compensatory responses in other aspects of food choice, may hinder weight control.

The method used in this study allowed us to derive not only the norm for each participant, food and norm task, but also the slope at the norm. This is a measure of the sensitivity to the stimulus, which indicates the certainty of the norm; a steeper slope indicates greater certainty, and a shallower slope indicates less certainty. In modelling the curves for each participant it was apparent that there was a much shallower slope for social norms compared to personal norms, which could be interpreted as less certainty over the portion size estimates for social norms. Men and the obese group also demonstrated shallow slopes for personal norms, suggesting that these groups are less certain about their portion size estimates for norms and that the portion sizes they habitually choose could be less clearly defined. Less certainty over personal norms for portion size could be associated with increased susceptibility to external cues in the food environment which could increase food intake. However, this study cannot explore that relationship or determine causality.

The differences in personal norms observed between men and women are consistent with previous studies and give confidence in this methodology to detect differences between individuals. For example, using weighed diet diaries, from the National Diet and Nutrition Survey 2000/1, and 24 hour diet recall, in an Australian survey, men reported consuming more of the vast majority of food groups [20, 21], and a study assessing ideal portion size using a computer task found men reported larger portions than women for half of the foods [13]. These findings support the notion that men may meet their greater energy needs, at least in part, through larger habitual portion sizes.

The larger personal portion size norms among obese versus lean participants is particularly striking because such differences are generally not observed in dietary surveys of reported

food intake [21]. There is known to be a greater magnitude of under-reporting of energy intake relative to energy requirements [22] in the obese and these data imply that systematic differences in the accuracy of reported portion sizes between lean and obese participants may be a possible source of this error in self-report data on food intake, which may be confounded by reliance on potentially inaccurate standard portion sizes in dietary assessment. However, it is important to note that while significant the difference in personal norms between lean and obese groups in the present study was small.

It is perhaps unsurprising that personal norms were larger for those foods more liked and a previous study on portion size selection found liking to predict larger lunch portion sizes of several snack foods [14]. Although it is intuitive that higher dietary restraint would be associated with smaller personal norms for portion size, most previous work has not indicated a clear effect of restraint on portion size selection [10, 13, 14] and most objective measures of energy intake do not show that restrained people eat any less [23, 24]. The current study did find that individuals with higher dietary restraint had smaller personal norms than those with lower restraint. Future research should explore whether this discrepancy between reported norms and observed behaviour is present when the two outcomes are measured in a single population. Without this it is difficult to infer whether this reflects a true difference in norms between restrained and unrestrained eaters or whether the norms task is susceptible to similar biases as other self-report measures.

Personal norms were larger than social norms only in the obese group, in men, in those with lower dietary restraint and higher liking. This indicates that these groups consider themselves to usually eat more of the study foods than others, whereas women, those with lower BMIs, higher dietary restraint, or lower liking tend to believe that others eat the same amount as they do. Social norms were remarkably consistent across the groups suggesting that most of

the differences between personal and social norms were down to personal variability in preferred portion sizes. This finding is important as it suggests that the observed increases in personal norms for some individuals cannot be explained in terms of a systematic perceptual bias in under-estimating the sizes of the portions used in this task. It also suggests the observed increase in personal norms for some individuals is not the result of choosing personal norm portions that conform to unusually large social norms. It is notable that gender did have an effect on social norms, whereby social norms were larger in women than in men. This may be because, although social norms are intended to represent the behaviour of 'most other people' in general, the social norm reported by those of one gender may be swayed by an undue weighting towards the perceived behaviour of the other gender.

The findings that subject characteristics can affect norms and the relationship between norms suggests that there is potential for inter-individual differences to affect the implementation of interventions to alter social norms, which has been proposed as a strategy to influence intake [25]. The observed differences between personal and social norms for men, in those with lower dietary restraint and higher liking could indicate that participants' ratings of social norms may take into account a different perceived typical portion size consumed by others of the opposite characteristic. However, this explanation would simultaneously suggest that a disproportionate weight is given to the opposite extreme of the characteristic in the perception of 'most other people'. In other words, for example, men perceive the collective of 'most other people' to be predominantly female, and *vice versa*. Thus, future research might seek to explore more nuanced social norms (i.e. most other people like you) and the extent to which this predicts their personal norms.

It is notable that the portion size index was greater than one across all foods, indicating that on average, norms for all foods were larger than the standard UK reference portion sizes.

These standards were originally compiled in the 1990s to assist in estimating portion sizes when coding diet diaries, however they may also be used by the food industry when constructing portions size guidance schemes [1]. This suggests that the reference portion sizes may no longer reflect what people actually consume, and calls into question the appropriateness of using these standard portions to estimate food intake in dietary assessment of free-living individuals. Additionally it further suggests that people may not use standard portion advice when making decisions about portions, relying inside on personal experience or other sources.

Limitations

There are several limitations to note. The study only attempted to measure the norms for a small range of items and only 17 different portion sizes of each food were shown. It is possible that the method used lacked some sensitivity in determining the norms and would have benefitted from the inclusion of more portion sizes and across a wider range of the total diet. However, this would have led to a dramatic increase in the time it took to complete the task thus impacting on participant burden. Although it was impossible to hide the purpose of the study from participants, the current task is likely to be less susceptibility to demand characteristics than typical self-report dietary measures. Finally, the sample size was relatively small.

Conclusions

In conclusion, personal norms for portion sizes were larger among the obese, men, those with lower dietary restraint, and those with higher liking, suggesting that these groups normally consume larger portions. The shallower slopes for norms in the obese and in men imply less clearly defined habitual portion sizes, which may be associated with greater susceptibility to external cues. The finding of differences in the slopes of the portion size norm response

curves between obese and lean participants is particularly striking and warrants further attention in the field. This computer based task provides a promising approach to study portion size norms and as it attempts to measure habitual portion sizes it may be a useful supplement to other dietary assessment techniques.

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SEF, HBL, ALA and SAJ designed and set up the study. HBL, KV, ER and SH conducted the research. HBL analysed data, interpreted results, and drafted the manuscript. SEF, ALA, KV, ER, SH and SAJ interpreted results and critically revised the manuscript. We thank all of the volunteers who took part in the study. This study was supported by a program grant from the UK Medical Research Council (U105960389).

Conflict of Interest

No authors declare a conflict of interest.

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Figure 1: Use of the method of constant stimuli task to derive a norm for portion size and associated sensitivity to the stimulus (the example shown is for the modelling of the personal norm for pasta for one participant).

Figure 2: Geometric means and 95% confidence intervals for portion size index for personal norms and social norms according to A) BMI group, B) gender, C) level of dietary restraint, and D) level of liking. *p<0.05; **p<0.01; ***p<0.001.

Figure 3: Illustration of the nature of the difference in the slopes of the response curve between lean and obese participants.

Figure 4: Geometric means and 95% confidence intervals for the slope of the modelled curve at the norm according to A) type of norm, B) BMI group, C) gender, D) level of dietary restraint, and E) level of liking. *p<0.05; **p<0.01; ***p<0.001.

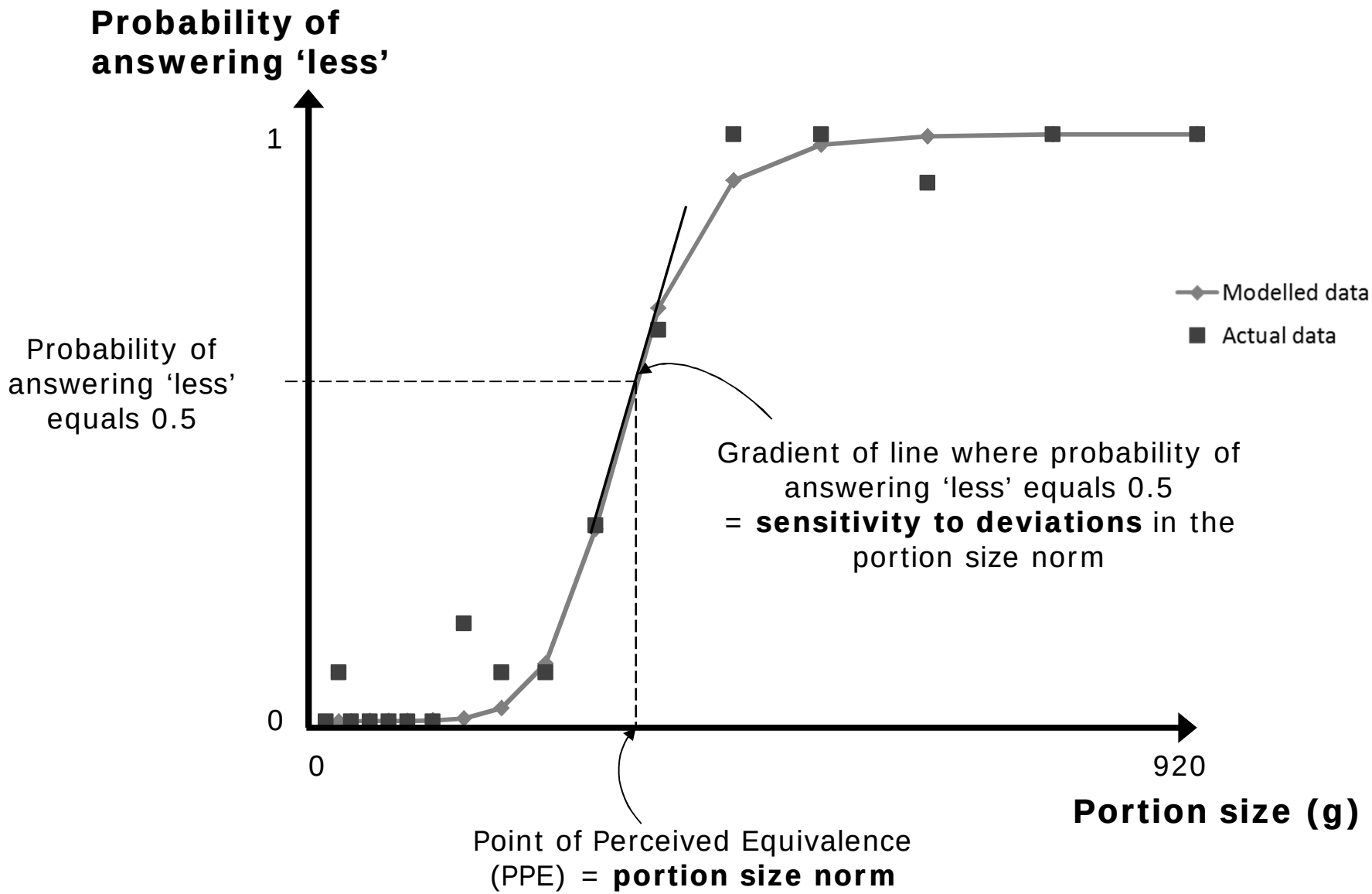
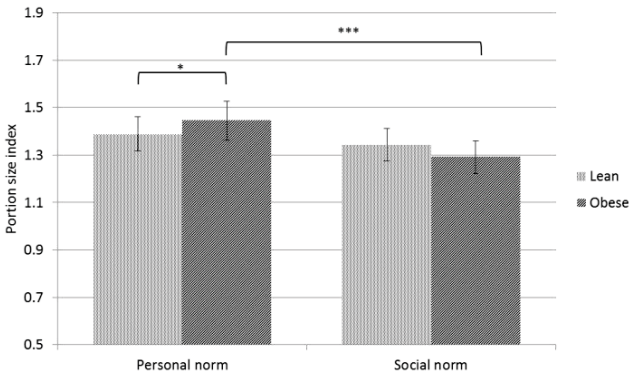
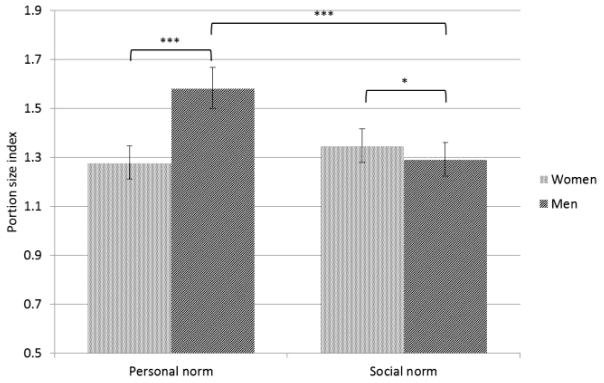


Figure 2

A)



B)



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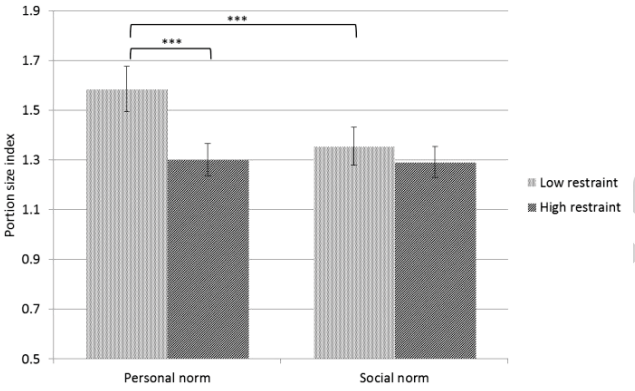
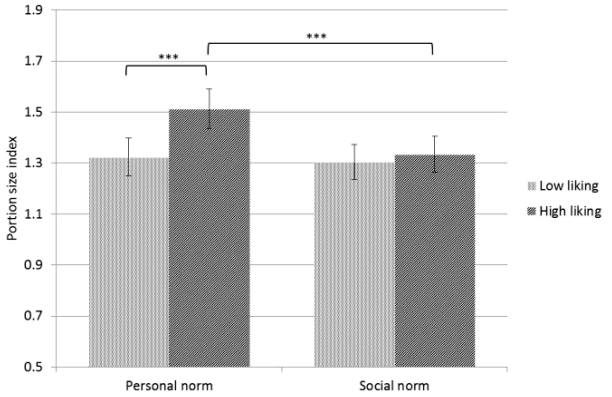


D)



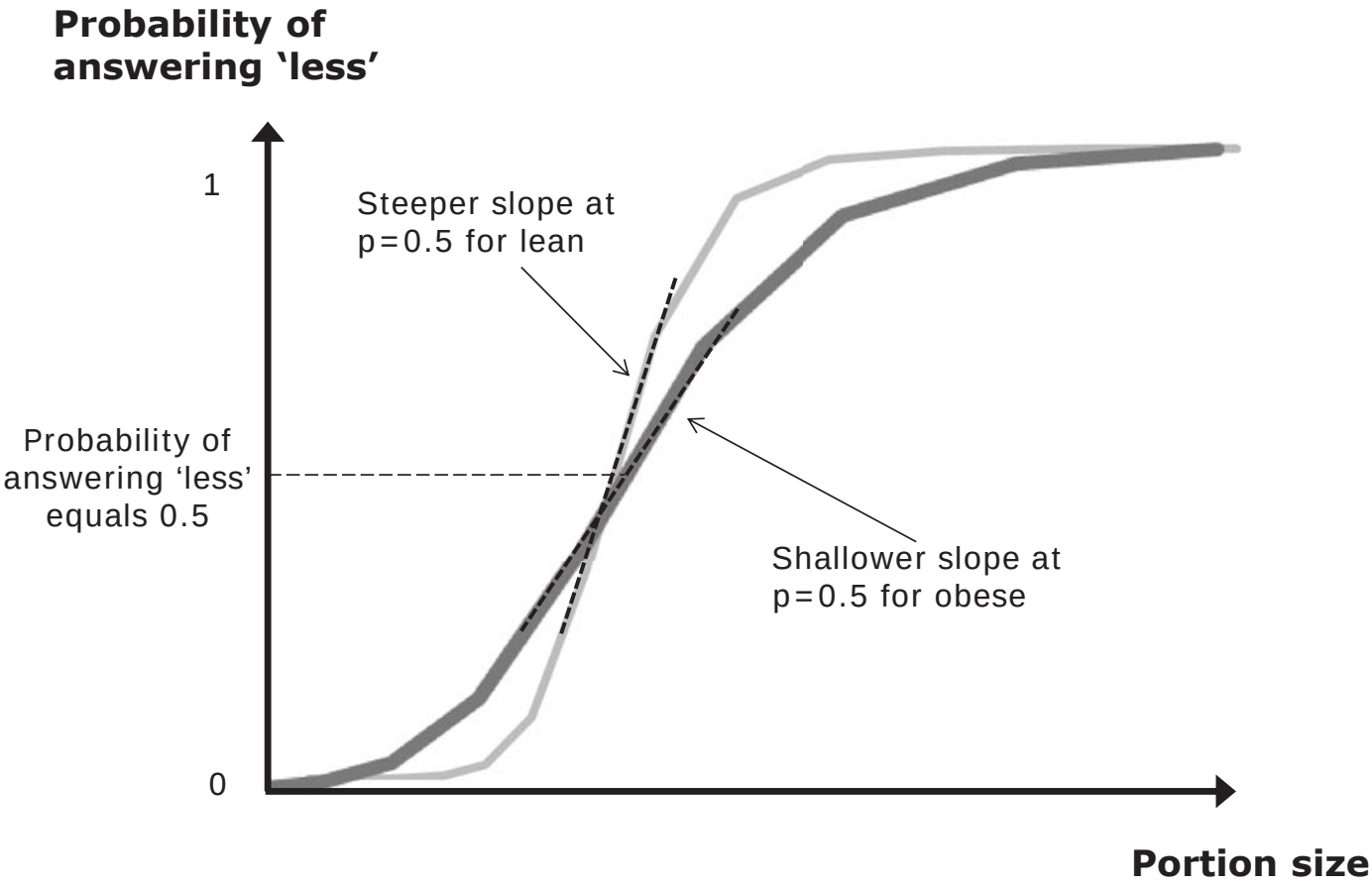
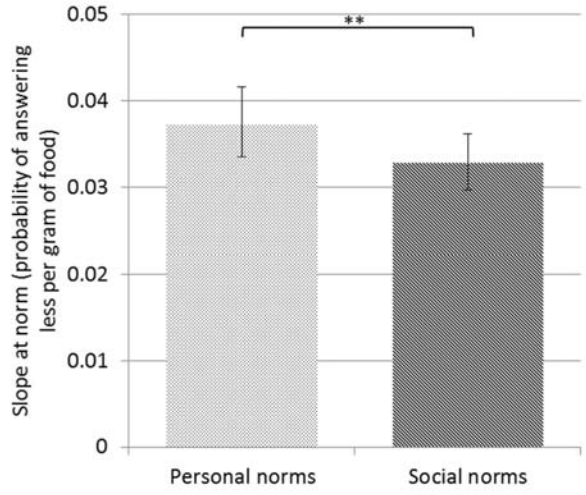


Figure 4

A)



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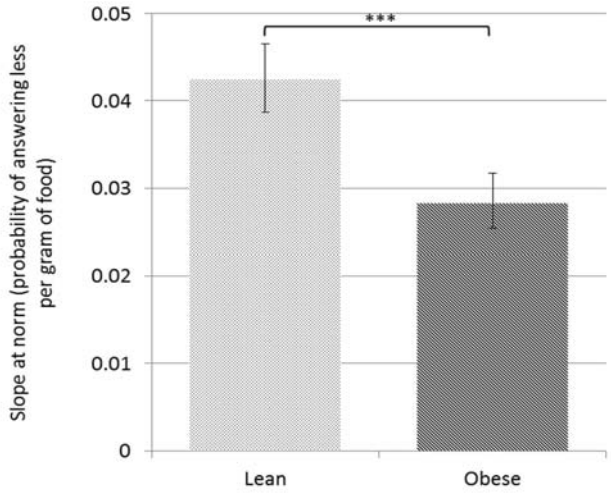
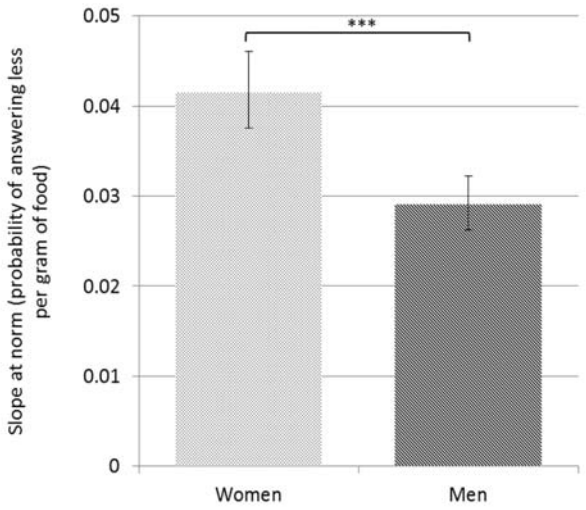
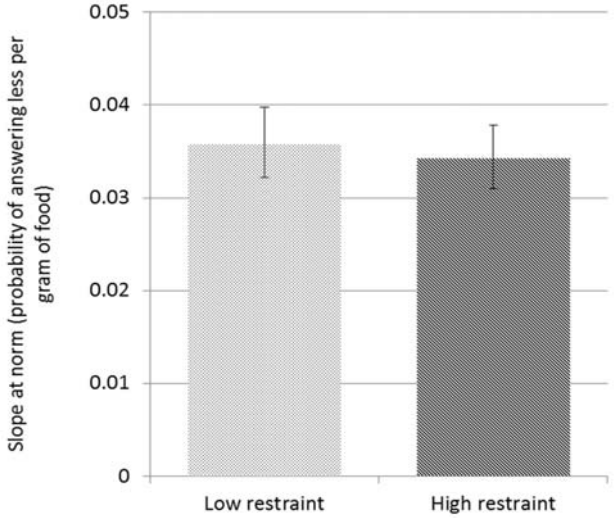


C)



D)



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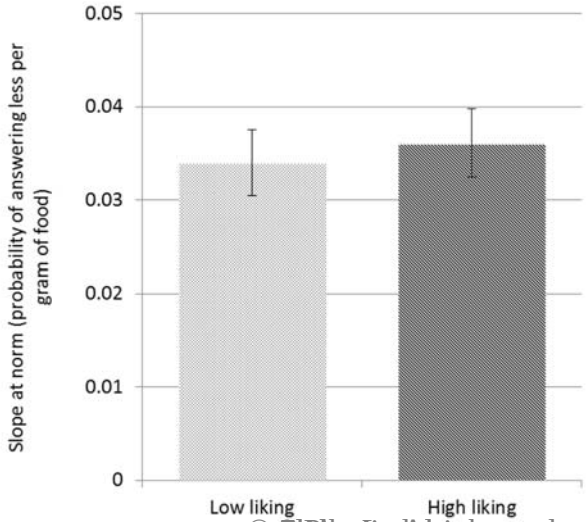

Table 1: Participant characteristics.

Characteristic	**Lean (n=30)**	**Obese (n=30)**
Height (m)	1.75 (1.63-1.82)	1.76 (1.66-1.8)
Weight (kg)	68.3 (61.3-74.0)	98.1 (90.6-102.6)***
BMI (kg/m^2)	22.7 (21.7-24.3)	32.1 (31.2-33.4)***
Age (years)	27 (24-36)	24.5 (21-33)
Dietary restraint (TFEQ score)	6 (5-8)	9 (6-12)**
Disinhibition (TFEQ score)	4 (3-6)	9 (6-11)***
Hunger (TFEQ score)	4 (3-7)	7 (6-10)**

Median (interquartile range)
BMI: Body Mass Index; TFEQ: Three Factor Eating Questionnaire
*p<0.05; **p<0.01; ***p<0.001

Table 2: Average personal and social norms for portion sizes.

Food	Portion size (g)	
	Personal norm	**Social norm**
Banana	109.5 (109.1-117.5)	114.4 (109.1-121.7)
Digestive biscuits	53.0 (38.7-76.4)	46.1 (35.4-55.4)
Chocolate cake	67.5 (47.7-87.0)	55.7 (41.7-81.2)
Cheese	52.0 (32.4-74.7)	50.7 (34.2-62.6)
Orange juice	380.4 (288.3-493.7)	393.9 (276.1-466.5)
Lasagne	403.1 (330.4-547.9)	354.5 (280.0-467.2)
Muesli	84.6 (59.0-135.4)	100.5 (71.9-131.8)
Pasta	284.1 (238.9-401.9)	252.8 (199.4-308.3)
Peas	115.6 (83.3-150.5)	103.3 (80.6-132.5)
Sandwiches	194.9 (167.3-225.9)	178.6 (159.0-201.3)
Sausages	123.2 (90-155.8)	105.5 (84.5-131.0)
Smarties®	60.0 (47.2-86.5)	62.0 (42.9-77.8)

Median (interquartile range)